

# #19: CE Stage with Emitter Degeneration

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Youtube: Lec.22

2014142023 하동호

# Cascaded Stages

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2 Stage amplifier  
= Cascaded amplifier

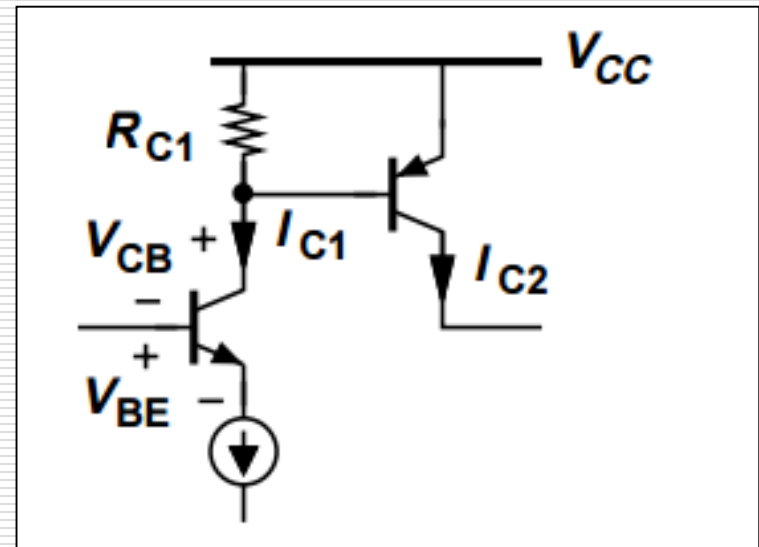
$$\frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_x} \times \frac{V_x}{V_{in}}$$

$$A_{V1} = -g_{m1} (R_{c1} \parallel r_{\pi2})$$

$$A_{V2} = -g_{m2} R_{c2}$$

$$\frac{V_{out}}{V_{in}} = g_{m1} g_{m2} R_{c2} (R_{c1} \parallel r_{\pi2})$$

$$\frac{V_{out}}{V_{in}} = g_{m1} g_{m2} (R_{c2} \parallel r_{o2}) (R_{c1} \parallel r_{\pi2} \parallel r_{o1})$$



# Problem of Gain Variation

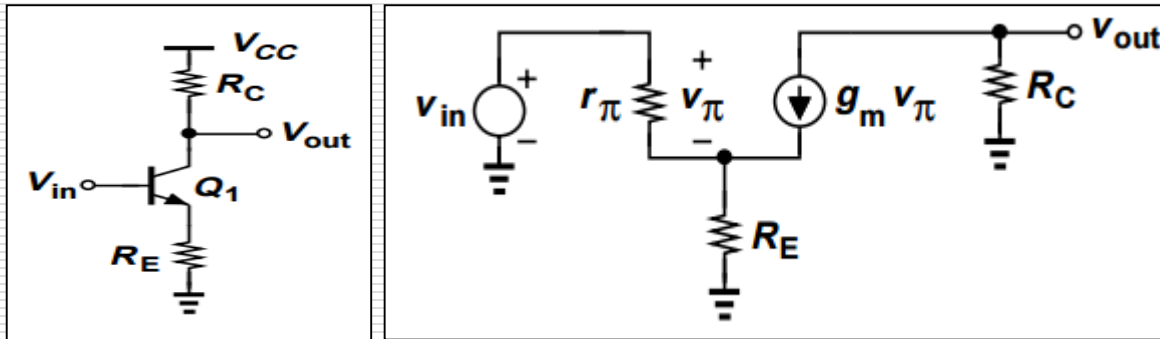
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$$A_V = -g_m R_c = -R_c \frac{I_c}{V_T}$$

$$I_c = I_s \exp\left(\frac{V_{BE}}{V_T}\right)$$

1. Temperature
2. Process
3. Signal Amplifier  
(Distortion, Non-linear)

# CE Stage with a emitter degeneration



$$g_m v_\pi = -\frac{v_{out}}{R_C}, \quad (5.149)$$

$$v_{RE} = \left( \frac{v_\pi}{r_\pi} + g_m v_\pi \right) R_E. \quad (5.151)$$

$$v_{in} = v_\pi + v_{RE} \quad (5.152)$$

$$= v_\pi + \left( \frac{v_\pi}{r_\pi} + g_m v_\pi \right) R_E \quad (5.153)$$

$$A_v = -\frac{R_C}{\frac{1}{g_m} + R_E}.$$